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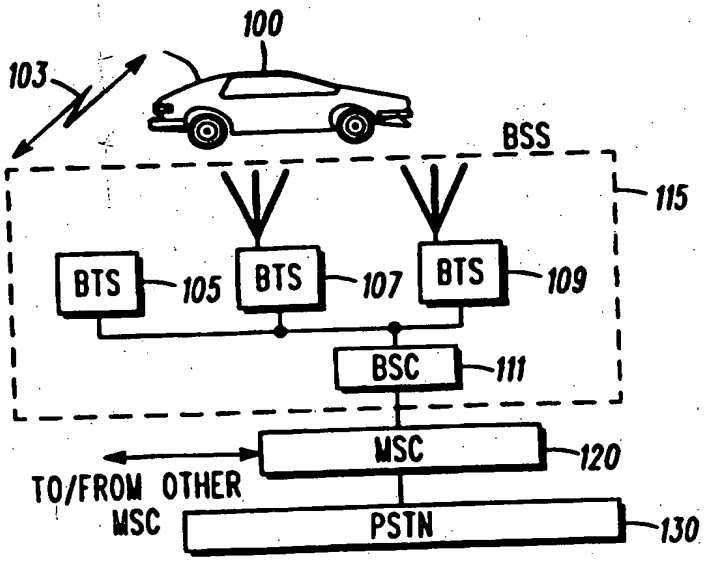
(54) Title: METHOD AND APPARATUS FOR ALLOCATING A COMMUNICATION CHANNEL IN A COMMUNICATION SYSTEM

(57) Abstract

A communication system (115) receives a paging signal (103) from a mobile station (100) requesting service and, if the paging signal (103) contains information identifying the service request as an emergency (502), a communication channel in a base transceiver station (105, 107, 109) is directly allocated to service the mobile station (100). If a communication channel is not immediately available, the communication system (115) will try to make a communication channel available. A distinct aspect of the communication system (115) is that it monitors an indicator (600) representative of the emergency call traffic on the communication system (115). Based upon the status of the indicator (600), the communication system (115) takes appropriate measures (440) to provide priority service for those mobile stations (100) having a priority access class. By providing priority service in this manner, the communication system (115) efficiently allocates the communication resource to the mobile stations (100) with priority access classes which need those resources urgently.



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METHOD AND APPARATUS FOR ALLOCATING A COMMUNICATION CHANNEL IN A COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to communication systems, and more particularly, to a method and apparatus for providing priority access service in a radiotelephone communication system.

BACKGROUND OF THE INVENTION

Wireless communication systems are well known and consist of many types including land mobile radio, cellular radiotelephone, personal communication system (PCS), and other communication system types. In cellular radiotelephone communication systems, for example, a number of communication cells, serviced by base transceiver stations (BTS), are typically linked to a base station controller (BSC) forming a base station system (BSS). The BSCs are, in turn, linked to a mobile switching center (MSC) which provides a connection between BSS and a public switched telephone network (PSTN), as well as the interconnection of BSSs. Mobile communication units (or mobile stations) (MS) operating within the communication cells utilize radio communication to transmit and receive signals with the serving BSS. The signals are processed by the BTS, BSC and MSC to complete a communication transaction with another MS, or through the PSTN to a land line telephone user.

In a particular type of radiotelephone communication system, for example a Global System for Mobile Communication (GSM)

radiotelephone communication system, the BSS is continuously transmitting a signal via the broadcast control channel (BCCH) to all MS within its signal range. This signal contains information necessary to allow a MS to access the system. Of particular interest within this signal is information regarding the access classes that the BSS will allow to access the system.

GSM Recommendation 4.08 defines three access classes: normal access, emergency access, and special services access classes. There are ten normal access classes (random from 0-9), an emergency access class (10), and five special services access classes (11-15). Hereinafter, when referencing the emergency access class and the special services access classes cumulatively, they will be referred to as the "priority access class" as distinct from the normal access classes.

In a typical MS call origination sequence, a MS will enter a communication cell, receive the BCCH and determine if it has the proper access class to be serviced by the BSS within that cell. If so, the MS may request service on the BSS via a one byte message signal commonly referred to as a random access burst (RAB) sent on the random access channel (RACH) to the BSS. If the MS does not receive a response to the RAB from the BSS within a time interval, the MS will time-out and issue a second RAB. For security reasons, the RAB contains very little information, and is void of information concerning the specific identity of the MS requesting service. Therefore, the BSS has no way of discerning that the second RAB is from the same MS as the first RAB and will attempt to service both of these requests when, in fact, there is only need to service one. As a result, communication resources in such a system are inefficiently allocated.

This phenomena may be particularly problematic in a situation where priority access is required by the MS user, in an emergency situation, for example, where the user may need immediate access to the system. Although the one byte RAB is void of information concerning the specific identity of the MS, it does contain a single bit referred to as the emergency word (EW) which, if enabled, will distinguish the request as an emergency access request. The EW can be enabled in one of three ways: the MS has an emergency access class (10); the MS has a normal access class, but is attempting to make an emergency call (i.e. 911); or the MS has a special services access class and is attempting an emergency call such as 911. Although the service request is identified as an emergency via the EW, the specific identity of the MS remains unknown. Therefore, the scenario of multiple RABs leading to an inefficient loading of the BSS remains valid. The result is that the BSS is operating inefficiently at a time when the user needs the prompt service of the BSS the most.

Thus, there is a need for a method and apparatus for providing prompt access to a radiotelephone communication system to service priority access calls without unduly loading down the system and without forfeiting the security provided by the current RAB structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 generally depicts a block diagram of a cellular radiotelephone communication system suitable for incorporating priority access service in accordance with the present invention;

FIG. 2 depicts an example flow chart illustrating an embodiment of the prior art call processing sequence for a normal access service request;

FIG. 3 generally depicts a block diagram of a radiotelephone communication system incorporating the priority access service feature in accordance with the present invention;

FIG. 4 provides an example flow chart illustrating an embodiment of the priority access service in accordance with the invention;

FIG. 5 generally depicts an illustration of the RAB structure as defined in GSM Recommendation 4.08; and

FIG. 6 generally depicts a relationship between the indicator and the ratio of the number of emergency service requests received to the number of communication channels available within a communication system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A communication system 115 receives a paging signal 103 from a mobile station 100 requesting service and, if the paging signal 103 contains information identifying the service request as an emergency 502, a communication channel in a base transceiver station 105,107,109 is directly allocated to service the mobile station 100. If a communication channel is not immediately available, the communication system 115 will try to make a communication channel available. A distinct aspect of the communication system 115 is that it monitors an indicator 600 representative of the emergency call traffic on the communication system 115. Based upon the status of the indicator 600, the communication system 115 takes appropriate measures 440 to provide priority service for those mobile stations 100 having a priority access class. By providing priority service in this manner, the communication system 115 efficiently allocates the communication resource to the mobile stations 100 with priority access classes which need those resources urgently.

The invention comprises a communication system 115 which allocates a communication channel in the system to a user 100 requesting emergency service 502. The communication system 115 accomplishes this by, first, receiving a signal 103 from the user 100 which contains emergency service information 502. Based upon the status of the emergency service information 502 contained within this signal 103, the communication system 115 will directly allocate a communication channel to service the emergency service request rather than wasting time going through the standard call processing sequence of FIG. 2. In the instance where a communication channel is not readily available, the communication system 115 will allocate a control channel to temporarily house the emergency service request while simultaneously freeing up a voice channel, thereby creating a newly available communication channel. The newly available communication channel is then allocated to the emergency service request.

Another aspect to this communication system 115 is that it proactively limits access to those users with a priority access class in times of emergency 440. The communication system 115 accomplishes this by receiving a plurality of signals 103 from a corresponding plurality of users 100 with a priority access class; monitoring an indicator 600 which represents the emergency call traffic on the communication system 115; and, when the indicator 600 reaches a certain threshold, denying access to the communication system 115 to all but those users with a priority access classification 440. Therefore, in accordance with the claimed invention, another improvement over the prior art is that the communication system 115 will track an indicator 600 representative of the emergency access load on the communication system 115 and, upon reaching a

threshold, will deny all but priority access requests 440 thereby providing optimal service for these users.

The present invention is described in an exemplary embodiment associated with a Global System for Mobile Communication (GSM), time division multiple access (TDMA) radiotelephone communication system. It will be appreciated by one skilled in the art that the present invention may be applicable to any radiotelephone communication system type, for example analog, code division multiple access (CDMA), or other TDMA types. Referring to FIG. 1, herein is depicted a block diagram of an example cellular radiotelephone communication system suitable for incorporating priority access service in accordance with the present invention. Shown in FIG. 1 is a radiotelephone communication system which includes a plurality of base transceiver stations (BTS) 105-109 serviced by a base station controller (BSC) 111, which make up a base station system (BSS) 115. The BSC 111 is coupled to an mobile switch center (MSC) 120 which in turn is coupled to a public switched telephone network (PSTN) 130. Mobile stations (one of which is shown as MS 100) operate in communication cells serviced by BTSs 105-109 and communicate with one of BTSs 105-109 via radio frequency (RF) signals 103 in a known manner. Calls originating with, or terminating at, a MS 100 are processed through the MSC 120 to either a wireline telephone customer linked to PSTN 130 or other radiotelephone communication system users serviced by MSC 120 or other MSCs (not shown).

In the preferred embodiment, mobile stations (MS) 100 serviced by the BSS 115 are assigned access classes, for managing access to the BSS. To request the service of the BSS 115, the MS 100 will transmit a signal 103, commonly referred to as a page, to all BTSs 105-109. In the preferred embodiment, the page is referred to as a random

access burst (RAB), an eight bit (one byte) message sent by a MS 100 to all of the BTSs 105-109 within a BSS 115 requesting service. Of particular interest within the RAB is the emergency word (EW) which, if enabled, will identify the service request as an emergency call.

Referring to FIG. 5, an example representation of the 8-bit RAB 500 structure is shown identifying the 3-bit EW 502 within the RAB 500. The EW 502 may be enabled in one of three ways: the MS 100 has an emergency access class; the MS 100 has a normal access class, but is attempting to make an emergency call (i.e. 911); the MS 100 has a special services access class and is attempting an emergency call such as 911. Therefore, although the BSS 115 does not know the specific identity of the MS 100, it does know that the service request is an emergency when the EW 502 contained within the RAB 500 is enabled. In the preferred embodiment, when the EW 502 is enabled as identified above, it will be set to logic state "1" and, conversely, will be set to logic state "0" when disabled.

Referring to FIG. 2, a depiction of a flow chart illustrating an example embodiment of the prior art call processing sequence for a normal access service request is shown. Under normal calling conditions, when a MS 100 requests access on a BSS 115 it will send a signal 103 requesting normal service (i.e. the EW is not enabled), as shown in step 200. In step 202, the BSS 115 will allocate an available control channel to the MS 100 in response to this random request for service and signal the MS 100 that the BSS 115 has accepted its request for service 206. However, because a control channel is incapable of processing audio calls it may only be used for signaling purposes. Therefore, in step 208, while the MS 100 is temporarily resident on the control channel, the BSS 115 will signal the MSC 120 that the BSS 115 has an incoming call from a MS 100 so that in step 210, the MSC

120 may determine whether audio service is required. Unlike the control channel, the communication channel is capable of processing audio calls as well as signaling information. If, in step 212, the MSC 120 determines that a communication channel is not required, the control channel will handle the call 220. Alternatively, when in step 212 it is determined that a communication channel is required, the MSC 120 will inform the BSS 115 in step 214 that a communication channel is required. In step 216, the BSS 115 will determine which communication channel to allocate and inform the MS 100 via the control channel to tune to a specific frequency to access the communication channel 218 thereupon freeing the control channel.

In the context of the preferred embodiment of a GSM communication system, the control channel will hereinafter be referred to as a stand-alone dedicated control channel (SDCCH), while the communication channel will be referred to as a traffic channel (TCH).

Referring to FIG. 3, a representative example of a block diagram of a radiotelephone communication system incorporating the priority access service feature in accordance with the present invention is shown. In this embodiment, a signal 103 containing the RAB 500 is sent from the MS 100 to a BTS 105-109 antenna 502. The received signal 103 is routed through an amplifier 304 to the channel equalizer/detector 306 which senses the presence of RAB 500 within the signal 103. The communication channel determination/allocation device 310 then determines if the RAB 500 within the incoming signal 103 has the EW 502 enabled and, if so, will allocate the MS 100 to an available TCH. If the BTS 105-109 does not have a TCH available, the communication channel determination/allocation device 310 determines if a SDCCH is available and, if so, allocate it to the MS 100 while simultaneously

tearing down a TCH for use by the MS 100. If the communication channel determination/allocation device 310 determines that a SDCCH is not available, it will adjust an indicator 600 to account for the emergency call request in anticipation of future call requests. Once a TCH has been made available, the TCH will function in the known fashion 308,312,330,320,318,316 and 314. The communication channel determination/allocation device 310 is only used to determine if a TCH is available and, if so, allocate it to the MS while keeping a constant track, in the form of the indicator 600, of the number of emergency service requests that are received by the BSS.

FIG. 4 provides an example flow chart illustrating an embodiment of the priority access service in accordance with the invention. In step 400, the BSS 115 will receive a signal 103 from the MS 100 containing a RAB 500. In an emergency call origination sequence, in step 402, the BSS 115 will determine that the EW 502 of the RAB 500 sent by the MS 100 will be enabled and, after adjusting an indicator 404, the request will be immediately handled by any available TCH 408-412 which will signal the MS 100 that the BSS 115 has accepted its request, thereby providing optimal access for the emergency request. Thus, one improvement made by this invention over the prior art is that when the BSS 115 receives a RAB 500 with the EW 502 enabled indicating an emergency service request, the request will be handled immediately by any available TCH, instead of the SDCCH, thereby minimizing the time required to complete the call origination.

If, in step 408, the BSS 115 does not have an available TCH, it will allocate an available SDCCH 414-418 which will signal the MS 100 that the BSS 115 has accepted its request (just as in a normal random request for service) and begin to "tear down" a TCH carrying a non-emergency call 420. The "tear down" procedure closes the

communication path between a MS 100 and the BSS 115, thereby freeing a communication channel. In the preferred embodiment, the newly available TCH will be made available to the MS 100 temporarily resident on the SDCCH 422-424. Therefore, another improvement over the art is that when a TCH is not available, but a SDCCH is, the BSS 115 will temporarily place the MS 100 on the SDCCH (which will signal the MS 100 that the request has been accepted thereby preventing the time-out/re-RAB problem) and initiate a "tear down" of a lower priority call, thereby minimizing the time taken to provide the MS 100 with the service required.

When a BSS 115 does not allocate a SDCCH or a TCH to an emergency call at step 416, the MS 100 will not receive any response to its initial RAB 500. The MS 100 will time-out waiting for the BSS 115 to respond and, in step 416 will issue another RAB 500. Therefore, the BSS 115 may receive multiple RABs 500 from the same MS 100. Thus when a cell is heavily utilized, several non-emergency calls could be terminated in an effort to free one TCH for a repeat emergency RAB 500.

Since it is likely that several MSs 100 will attempt the same emergency call, the BSS 115 shall track an indicator in step 426 which will provide an indication of the extent of the emergency call traffic. When the indicator reaches a threshold 426 the BSS 115 will proactively limit the access of normal access classes 432 in favor of priority access classes. Therefore, another improvement over the art is that the invention allows a BSS 115 to react to an emergency situation by anticipating a heightened need for communication channels and reserving those channels for MSs 100 with priority access classes.

Finally, referring to the indicator referenced in step 426, FIG. 6 depicts one example of an indicator metric 600 that the BSS may employ in tracking the emergency call load placed on a system. Specifically, FIG. 6 represents an indicator 600 that is defined as being related to the ratio of the number of emergency service requests in a given amount of time 602 to the number of communication channels available in a given BSS 604.

In summary, the invention herein claimed makes two distinct improvements over the prior art. First, when the communication system receives a page with emergency service information, any available communication channel immediately handles the request directly, rather than the normal BSS-MSC communication cycle indicative of the prior art. Second, the communication system will track an indicator which is representative of the emergency call traffic placed on the system and, in times of emergency, will proactively deny access to the communication system to all but those users with a priority access service class. In concert, these two improvements provide for a much more responsive and efficient communication system in times of emergency.

What we claim is:

CLAIMS

1. A method of allocating a communication channel in a communication system, the method comprising the steps of:

receiving a signal containing an emergency service information from a first user;

determining whether there exists an available communication channel; and

allocating the available communication channel to the first user based upon a status of the emergency service information.

2. The method of claim 1, further comprising the steps of:

determining if there exists an available control channel if the communication channel is unavailable; and

allocating the available control channel to the first user if the control channel is determined to be available.

3. The method of claim 1, wherein the step of determining whether there exists an available communication channel further comprises the step of removing a second user without an emergency access class from a communication channel to produce an available communication channel.

4. An apparatus for allocating a communication channel in a communication system, the apparatus comprising:

means for receiving a signal containing emergency service information from a first user;

means for determining whether there exists an available communication channel; and

means for allocating the available communication channel to the first user.

5. The apparatus of claim 4, further comprising:

means for determining if there exists an available control if the communication channel is unavailable; and

means for allocating the available control channel to the first user if the control channel is determined to be available.

6. The apparatus of claim 4, wherein the means for determining whether there exists an available communication channel further comprises a means for removing a second user without an emergency access class from a communication channel to produce an available communication channel.

7. An apparatus for allocating a traffic channel in a base station system to a mobile station, the apparatus comprising:

means for receiving an access signal from the mobile station with an emergency word enabled;

means for determining whether there exists an available traffic channel; and

means for allocating the available traffic channel to the mobile station without first allocating a control channel.

8. The apparatus of claim 7, further comprising a means for allocating the control channel to the mobile station if the traffic channel is determined to be unavailable.

9. A method for providing a plurality of communication channels in a communication system to a corresponding plurality of users, the method comprising the steps of:

receiving a plurality of signals from the corresponding plurality of users;

tracking an indicator related to the number of signals received having priority access information; and

limiting access to the communication system to those users that have priority access information when the indicator reaches a certain threshold.

10. The method of claim 9, wherein the indicator is a ratio of the total number of signals received with priority access information to the total number of communication channels in the communication system.

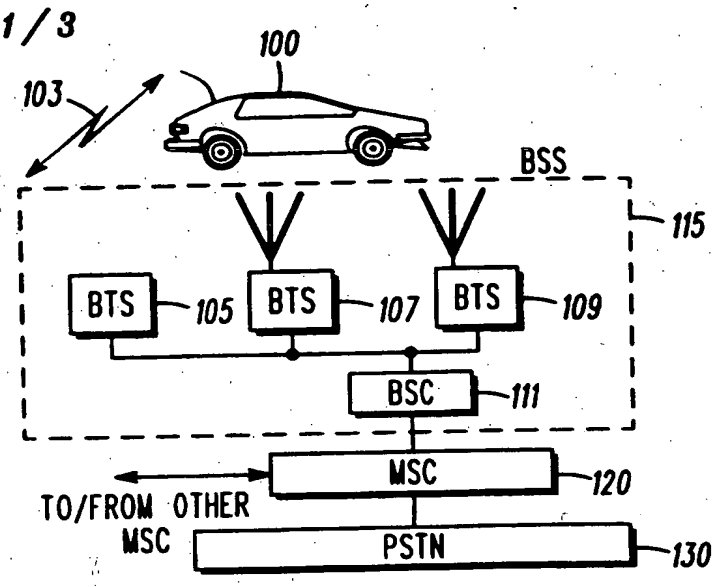

100
103
BSS
115
BTS
105
BTS
107
BTS
109
BSC
111
MSC
120
TO/FROM OTHER MSC
PSTN
130

FIG.1

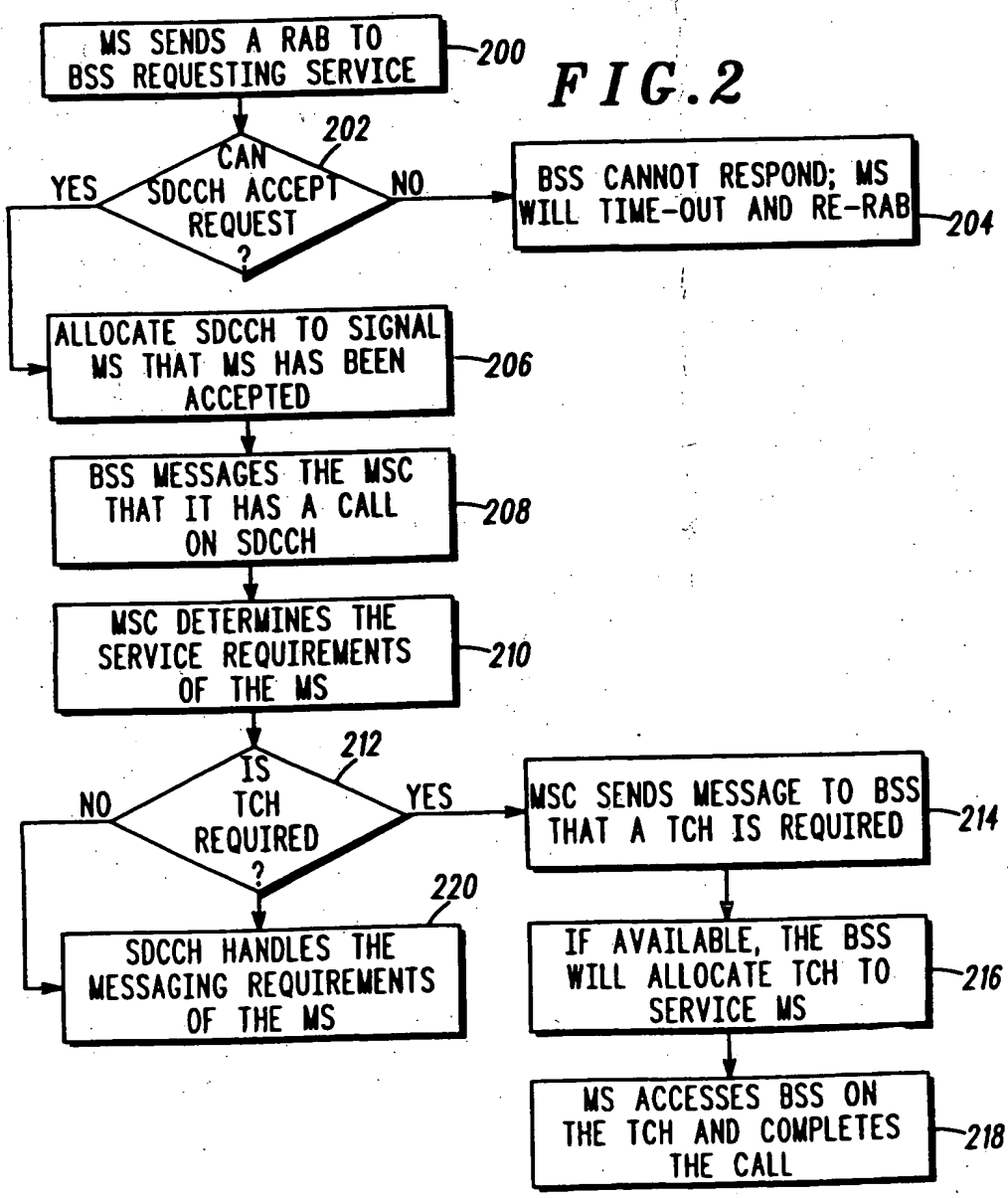

MS SENDS A RAB TO BSS REQUESTING SERVICE
200
CAN SDCCH ACCEPT REQUEST ?
202
YES
NO
BSS CANNOT RESPOND; MS WILL TIME-OUT AND RE-RAB
204
ALLOCATE SDCCH TO SIGNAL MS THAT MS HAS BEEN ACCEPTED
206
BSS MESSAGES THE MSC THAT IT HAS A CALL ON SDCCH
208
MSC DETERMINES THE SERVICE REQUIREMENTS OF THE MS
210
IS TCH REQUIRED ?
212
NO
YES
MSC SENDS MESSAGE TO BSS THAT A TCH IS REQUIRED
214
SDCCH HANDLES THE MESSAGING REQUIREMENTS OF THE MS
220
IF AVAILABLE, THE BSS WILL ALLOCATE TCH TO SERVICE MS
216
MS ACCESSES BSS ON THE TCH AND COMPLETES THE CALL
218

FIG.2

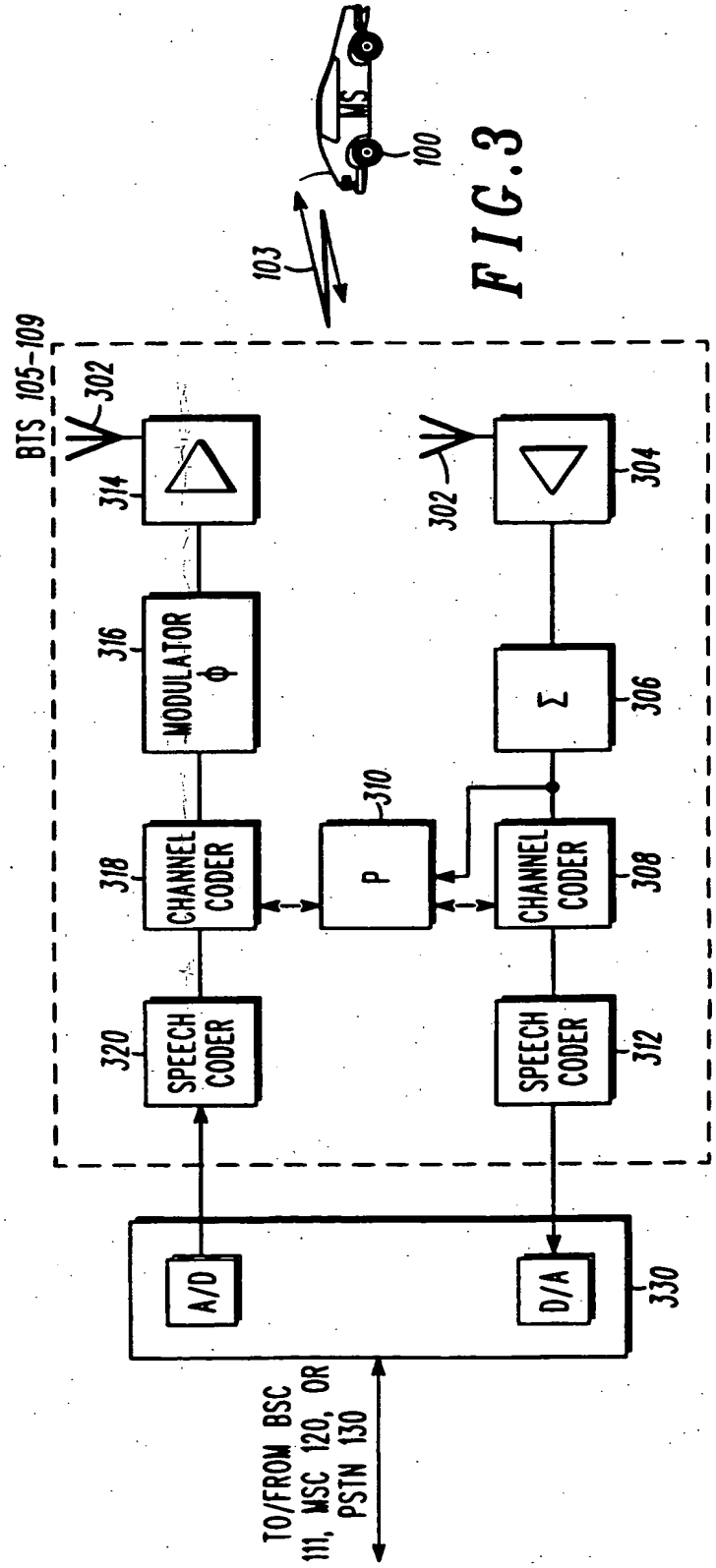

MS
100
103
BTS 105-109
302
314
316
MODULATOR
φ
318
CHANNEL
CODER
320
SPEECH
CODER
310
P
302
304
Σ
306
CHANNEL
CODER
308
SPEECH
CODER
312
A/D
D/A
330
TO/FROM BSC
111, MSC 120, OR
PSTN 130

FIG.3

FIG.4

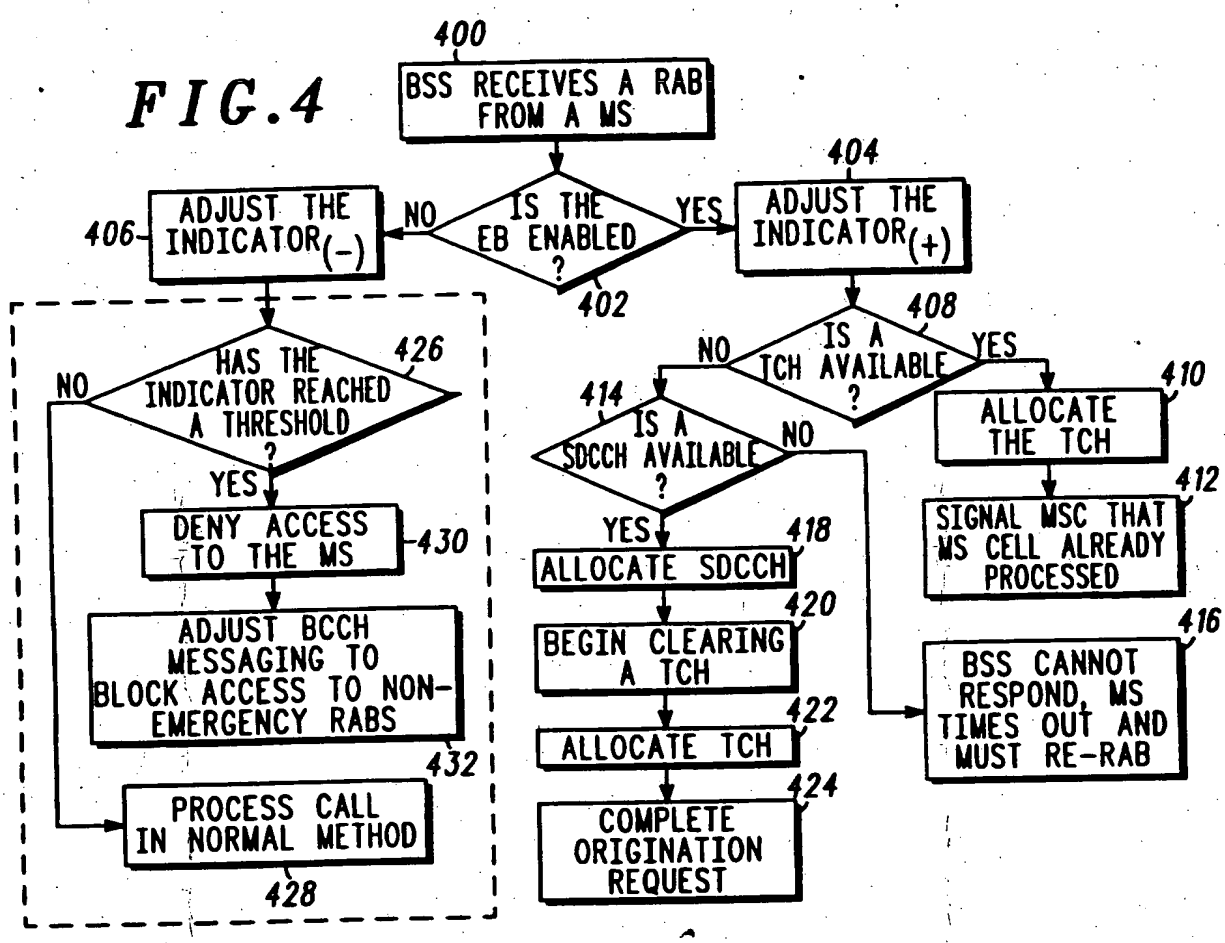
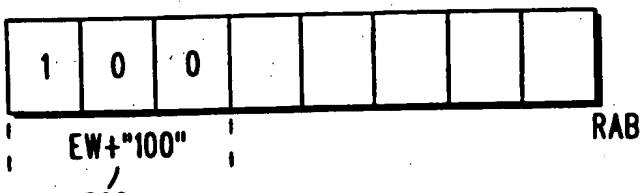


FIG.5



8-BIT RAB STRUCTURE

FIG.6

$$[\text{INDICATOR}] \approx \frac{[\text{EMERGENCY SERVICE REQUESTS/TIME INTERVAL}]}{[\text{TOTAL NUMBER OF COMMUNICATION CHANNELS IN A COMMUNICATION SYSTEM}]}$$

600 602 604

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/13483

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04Q 7/00
US CL : 455/34.1, 34.2

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/34.1, 34.2, 54.1, 62

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,214,789 (GEORGE) 25 MAY 1993 col. 7, lines 38-60.	1-10
Y,P	US, A, 5,491,837 (HAARTSEN) 13 FEBRUARY 1996, see the entire document, especially col. 1, lines 12-46.	1-10

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Date of the actual completion of the international search 07 DECEMBER 1996	Date of mailing of the international search report 14 JAN 1997
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